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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
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United Kingdom

THE PRODUCTION OF SULPHURIC ACID FROM ALTERNATIVE SOURCES OF SULPHUR

By J.D. McFARLANE
and V. ROBINSON

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THE PRODUCTION OF SULPHURIC ACID FROM ALTERNATIVE SOURCES OF SULPHUR

by J.D. McFarlane and V. Robinson

1. Elemental sulphur from a technological point of view is a very attractive material for the manufacture of sulphuric acid. Plant costs are generally lower than for other materials, and design, and operation are easier. The most important source of this material is underground deposits mined by the well-known Frasch process which gives a very pure product but, unfortunately, for most developing countries, the main deposits are in the United States and Mexico with an increasing production in Poland. Likewise the largest production of sulphur recovered as a byproduct of refinery or natural gas processing operations is probably at Lacq in France, with substantial quantities from Canada and America; none of these places can be termed "less developed areas". There are also other sources of natural sulphur such as the Sicilian Mines which have been known and worked since classical times together with mines in other countries: such materials tend to be more expensive and rather less pure than the Frasch or recovered sulphur and many of them are not suitable for the simplest type of sulphur burning acid plant.

2. Iron pyrites is the major alternative to sulphur as a raw material for sulphuric acid production. This is much more widely distributed than sulphur and a large part of world production is based on it. Normal high quality material contains about 48% by weight of sulphur so that raw material transport costs have a greater effect on plant location and manufacturing costs than when using sulphur itself. Furthermore, the residues of iron oxide cinder left from the roasting process may not be suitable for charging to the blast furnace and may therefore present a disposal problem. At the present time in countries such as Britain without indigenous sources of sulphur or pyrites sulphuric acid can be produced at about the same price from either; this is because the opposing effects of transport costs and the residual value of cinder are approximately in balance. Any decline in the value of the cinder as steelworks raw material would make pyrites based acid appreciably more expensive. The latter is in any case true for many countries situated a long way from a pyrites source.

3. Other sulphides as a source of sulphur are of considerable economic and technical interest, particularly to developing countries having ore deposits. Many non-ferrous ores occur as sulphides and require roasting in air before further smelting is possible to produce the metals. All these processes give rise to large quantities of gases containing SO_2 which used to be vented to atmosphere; this is still the practice in some parts of the world. However the effect of SO_2 in the atmosphere on vegetation was so deleterious that large areas of countryside were virtually laid waste by some of these earlier operations and restrictions have been imposed in most countries. Comparatively simple processes exist for absorbing the noxious gases but these generally are expensive to operate and give rise to large volumes of liquid effluents which may be nearly as

objectionable as the gases. Consequently, the practice of turning these SO_2 containing gases into a valuable industrial raw material was introduced and today, except in desert areas remote from population centres, the production of sulphuric acid is regarded as an essential part of these metallurgical operations.

4. The use of further alternative sulphur bearing raw materials may well be encouraged by many developing countries due to shortage of foreign exchange and in an effort to achieve economic self sufficiency regardless of the higher cost of acid thus produced from indigenous sources.

For example

(a) the process for making cement and sulphuric acid from calcium sulphate was developed in Germany during the First World War and the anhydrite process is still used in Britain.

(b) there is an increasing potential in hydrogen sulphide, particularly from petroleum refining and natural gas purification; it may, however, be more economic to make sulphur under some circumstances.

(c) "spent oxide" from the purification of carbonisation gases is often roasted for its sulphur content and the residual cinder value: this is likely to be a declining source since alternative processes for the purification of gas have been developed which either produce sulphur directly, convert the sulphur to an innocuous effluent, or produce sulphur dioxide gas which can be utilised in an acid plant.

(d) ferrous sulphate, produced in large quantities in the titanium dioxide pigment industry and in the pickling of iron and steel is also a possible alternative source.

5. The production of sulphuric acid from sulphur is in essence a very simple process.

(a) Sulphur is burnt in the presence of atmospheric oxygen to give SO_2 which then combines with further oxygen to give SO_3 gas in accordance with the following equations :

$$S + O_2 = SO_2$$

$$SO_2 + \frac{1}{2} O_2 = SO_3$$

$$SO_3 + H_2O = H_2SO_4$$

The reaction of SO_2 and oxygen is very slow and all commercial processes use a catalyst. The only catalysts of economic importance today, except under very exceptional circumstances, are based upon vandium pentoxide.

(b) Owing to considerations of chemical kinetics and equilibrium it is necessary to cool the SO_2 gas, before entering the catalyst beds, to a temperature of about 420°C and to abstract heat from the gas during the course of reaction. This heat may, together with that of the combustion of the sulphur either be rejected to atmosphere or recovered in the form of waste heat steam. Normally, except on very small plants it is economic to recover the heat and, even if no specific use for steam exists, it can be used to drive some of the machinery

on the plant. Indeed it is possible for the value of the steam on a large plant to very nearly pay for all the depreciation, labour, maintenance and services required by the plant so that the acid is obtained for very little more than the cost of the sulphur content.

(c) The sulphur trioxide formed cannot be absorbed directly in water because, as is well-known, it forms a very stable sulphuric acid mist under these conditions which is very difficult to recover, and it gives rise to atmospheric pollution. For the same reason, it is necessary to dry the air before the combustion of the sulphur. This is achieved on the plant by circulating some of the acid over a packed tower. A very much simplified flowsheet of a sulphur burning plant is shown in Figure I.

6. The production of acid from all the other sources mentioned is more complicated because the gases from most such sources cannot be treated in such a simple manner. Firstly, they generally contain appreciable quantities of dust which would plug the catalyst beds very rapidly and make the plant completely inoperable. Secondly, they may well contain some impurities which, while not harming the modern catalyst may temporarily reduce conversion efficiency and also contaminate the product acid. Consequently the methods of production of SO_2 containing gas, its purification and cooling, as mentioned below, have been developed. Furthermore, as the purified gas is then cold it has to be heated by heat exchange with the converted gas to give suitable operating temperatures in the converter. Some of the necessary unit operations are shown on the simplified flowsheet Figure II.

(a) The methods of production of SO_2 containing gases include

(i) at least four important different systems of pyrites roasting, and the actual selection in any particular case requires a careful balance of the conflicting requirements of gas strength produced, cinder quality, and production rate per unit: in all cases the ore is oxidised in atmospheric air at elevated temperature.

(ii) production from calcium sulphate in a cement-type rotary kiln for reduction of the sulphate by carbonaceous matter in the presence of an acidic oxide to combine with the calcium. It is, however, complicated by the economic necessity to produce an acceptable quality of cement simultaneously: this involves very careful blending of the raw materials and control of the firing conditions.

(iii) production from spent oxide in roasters of similar design to those used for pyrites but conditions are different and differences in detail occur.

(iv) production from hydrogen sulphide containing gases by simple combustion in air.

(v) ferrous sulphate reduction at high temperature by suitable fuel such as coal or oil, but there are complications due to the high moisture content of the gas both from combustion of the fuel and from the water of crystallisation of the ferrous sulphate.

(b) The primary product of the combustion of all these materials is a hot SO_2 containing gas which contains water vapour and generally, except in the case of H_2S burning, dust in suspension. Before use in a contact sulphuric acid plant the gases must be cleaned of dust to a very high degree of perfection. It is then necessary to dry the gases to a very low water vapour content before admission to the acid plant proper.

(i) dust removal is usually effected by the aid of cyclones and electrostatic dust precipitators which will normally recover 90 to 98% of the dust present. The degree of cleanliness required for a contact plant is, however, several orders of magnitude higher than this and the normal practice is to follow the primary purification with a wet washing system which cools the gases to a temperature in the order of 40°C. This process, however, does generate sulphuric acid mist arising from the small quantities of sulphur trioxide which are always found in the gases from the roasters and furthermore there are often metallic fumes present which, being in the vapour state, are not removed by the dust precipitators but are condensed (but only partly removed) in the washing system.

(ii) the removing of the acid mist and metallic fumes requires wet electrostatic precipitators which can clean to a very high degree of efficiency. The normal specification of the gas leaving the wet precipitator is that it shall be optically clear at a distance of several metres, and detection of impurities requires the most refined analytical methods.

(iii) in special circumstances an acceptable method of cleaning the hot gas and achieving the cooling in one operation can be achieved by using various types of impingement scrubber.

(d) An exceptional case is the modern wet catalysis process which is generally only suitable for treating H_2S gas which is free of all suspended solids. Under these circumstances, by the adoption of special techniques it is possible to dispense with the drying of the combustion air. Such plants, however, at the moment, only produce comparatively weak sulphuric acid which is acceptable for many purposes. Modern developments, however, open the possibility of producing concentrated acid, (about 92-95% strength) from such plants and it is anticipated that in the near future, such plants may be generally available.

7. Technically, it is possible to construct sulphur burning sulphuric acid plants of capacities of from less than 10 tons per day up to well over 1,000 tons per day, substantially in single stream units. This is not always true for other raw materials: for example it is doubtful whether the cement sulphuric acid process could be made to operate technically in capacities much under 50 tons per day.

TABLE I.

PRODUCTION COSTS OF SULPHURIC ACID

Showing variation with plant size and raw material.

Raw Material	Sulphur			Pyrites		Calcium Sulphate	
Capacity tons per day	25	100	500	100	500	100	500
Debits							
Raw Materials	74	74	74	75	75	65	65
Services	4	4	4	8	8	16.5	16.5
Maintenance	9	8	5	15	12	24	24
Labour	2	1	0.2	2	0.5	6.5	6.5
Fixed Charges	26	13	8	30	20	60	48
	115	100	91.2	130	115.5	172	160
Credits							
Steam	15	20	20.0	18	18		
By Products				24	24	80	80
Net Cost	100	80	71.2	88	73.5	92	80

All costs are based on U.K. values and given in shillings per metric ton of 100% sulphuric acid, and exclude all factory overheads.

8. Table I shows the economic problems inherent in the fixed charges on small plant. In the U.K. it is normally uneconomic to operate sulphur burning acid plants of less than about 50 tons per day or pyrites burning plants of less than 100 tons per day.

   The table also shows the substantial increase in fixed charges for two alternative raw materials, pyrites and calcium sulphate. It is also apparent that running below rated capacity (when the fixed charges increase per ton of product) is least important with sulphur as raw material.

9. In less developed countries the economics of small plants are much more attractive.

   (a) Many sulphur burning plants of the 10 ton per day size have been built which can operate economically at this rating and even lower.

   (b) Pyrites burning plants also have been built on the scale of 10 tons per day and can run economically if the raw material is available locally. Only under very exceptional circumstances is it economic to build plants of much lower capacity although these are technically feasible.

(c) Unfortunately the demand for very small plants is so low that the design costs incurred in the building represent a very substantial proportion of the initial cost and consequently, the price of a 5 tons per day plant would be nearly as great as 10 tons per day plant. It might even be higher, as most suppliers of such equipment have standard designs available for the 10 ton plant.

10. While the basic principles of sulphuric acid production have been the same for many years, continual research and development by manufacturers of these plants have reduced the costs in terms of a constant value of money very considerably. These developments involve improvements in the process design and in the application of the latest techniques in gas cooling and cleaning, and today, sulphuric acid can be made from almost any sulphur-bearing material by processes which are amply proved in commercial production. This experience and techniques are freely available to all parts of the world and should allow developing countries to make the best use of their available resources.

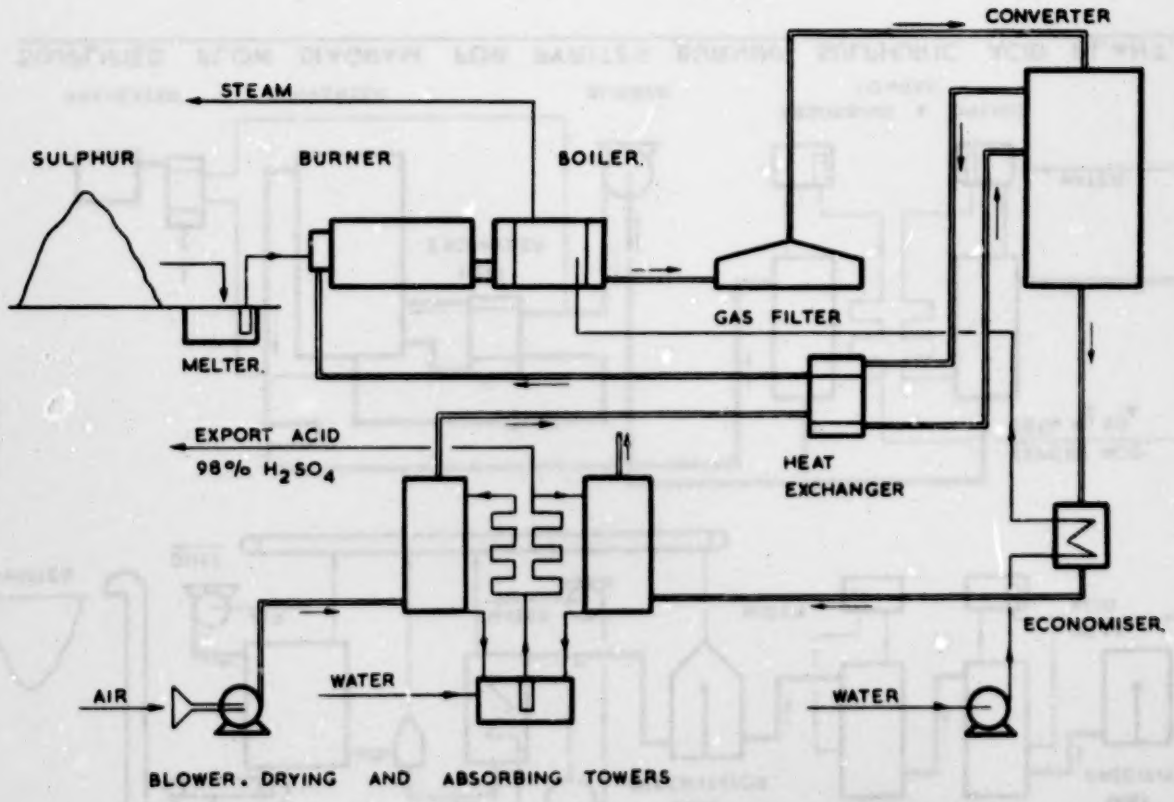

FIGURE I

SIMPLIFIED FLOW DIAGRAM FOR SULPHUR BURNING SULPHURIC ACID PLANT.

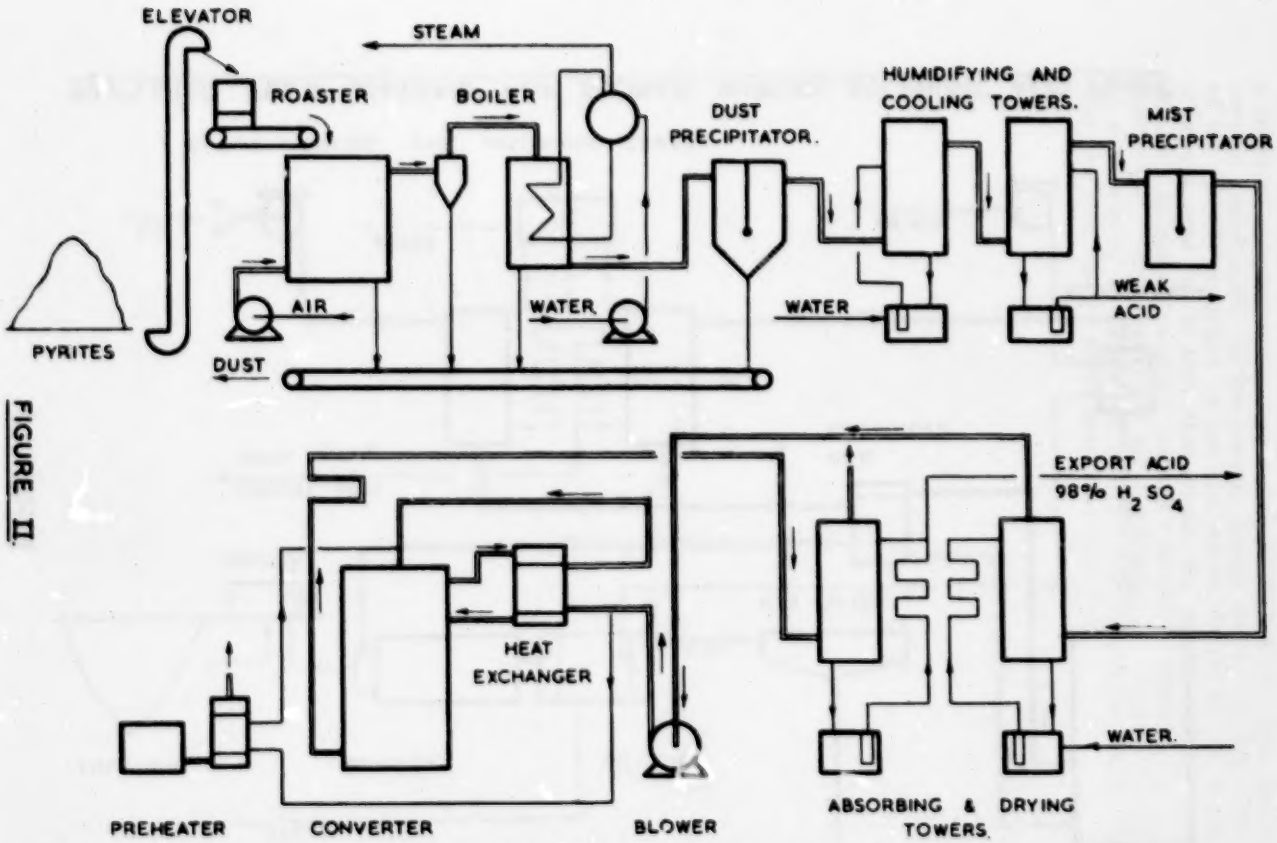

FIGURE II.

SIMPLIFIED FLOW DIAGRAM FOR PYRITES BURNING SULPHURIC ACID PLANT.

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AUTHORS' SUMMARY

THE PRODUCTION OF SULPHURIC ACID FROM ALTERNATIVE SOURCES OF SULPHUR

by J.D. McFarlane and V. Robinson

a) Sources of Sulphur

In most places in the world the cheapest sulphuric acid is made from the burning of raw sulphur. This is obtained mainly from the United States and Mexico or from sulphur recovered in gas purification at Lacq in France. This means that developing countries must use alternative indigenous sources of sulphur bearing material or must import sulphur.

The major alternative to sulphur is iron pyrites and this is widely distributed so that it is available in some of the developing countries. The cost of acid produced from it depends to a great degree upon the distance the pyrites must be transported: it also depends on the value of the residual iron oxide cinder, the latter is affected by the arsenic content and the amount of copper which can be leeched out and by the proximity of an iron and steel works.

Many developing countries are favoured with ore deposits containing sulphides of non-ferrous metals. These ores require roasting before the metal can be smelted and during the roasting operations large quantities of gas containing SO_2 are produced. In the past all this was wasted to the detriment of the surrounding countryside, today it is normal for these gases to be treated and for them to be converted into sulphuric acid which has become an essential and valuable by product.

Other alternative sources of sulphur which are at present used for making sulphuric acid include calcium sulphate and anhydrite. The process here involves a combination of cement and sulphuric acid production. In addition hydrogen sulphide arises in many purification processes as a by product and this can be turned into sulphuric acid or some times into sulphur. Further alternative sources are the roasting of "spent oxide" from the purification of carbonisation gases, also the roasting of ferrous sulphate from the titanium dioxide and iron and steel pickling industries.

b) Production of sulphuric acid from elemental sulphur is essentially simple. The sulphur is burnt in the presence of atmospheric oxygen to give SO_2 which is then combined with further oxygen over a catalyst to give SO_3 gas. The catalysts today are based mainly on vanadium pentoxide and process kinetics require a temperature of about 400°C to be maintained through the several beds of catalysts by extraction of heat between stages. The recovery of the heat of combustion of the sulphur and conversion of the SO_2 to SO_3 can produce steam which may be sufficiently valuable to enable the acid to be produced for little more than the cost of the sulphur.

The production of acid from other raw materials is appreciably more complicated, firstly in producing the SO_2 gas and secondly in treating it to make it clean enough for conversion to SO_3.

From pyrites a gas containing SO_2 can be achieved by roasting by one of several processes, the choice depending upon the type of pyrites, the gas strength produced, the quality of cinder required and the capacity of the plant. Similar roasters can be used for burning spent oxide whereas the use of calcium sulphate requires the cement type rotary kiln fed with suitable raw materials plus fuel so that the resulting gas is the right strength and the cement clinker of the required quality.

The gas containing SO_2 from the roasting of non-ferrous ores or from any of the processes just mentioned, normally contain water vapour and dust in suspension. The dust must therefore be removed by cyclones and electrostatic dust precipitators often followed by washing and cooling for further cleaning. Finally the cooled gas relatively dust free normally goes to wet electrostatic precipitators so that cooled dried gas is suitable for catalytic conversion (after reheating).

Occasionally a gas containing H_2S free from all suspended solids is available at suitable strength. This can be burned in a "wet" catalysis plant, though at present such plants can produce only comparatively weak acid. All the other plants mentioned can give 98% acid with ease or can be adapted to produce oleum.

In the paper flow diagrams are given.

c) Sulphuric acid can be produced from sulphur in single stream units from below 10 tons per day of acid to well over 1,000 tons per day. For other processes the minimum size for one stream may be larger and it may be necessary to go to multiple stream design for some parts of the plant at capacities of much less than 1,000 tons per day. day
In the developing countries the economics of small plants are frequently attractive for various special reasons. Elsewhere cost comparisons, given in the paper, show the advantages of large scale operation. For a country where pyrites does not need to be transported too far, and where there is a sale for the cinder, acid production costs for all plant capacities are similar to those from elemental sulphur. However the cost per ton of acid produced at 500 tons per day in one unit may be at least 10% less than the cost at 100 tons per day.

The cost of production from by product gases from say roasting non-ferrous sulphide ores depends entirely upon what cost if any is charged for these gases.

d) There is no doubt that there is available to the developing countries the necessary technical knowledge in gas production and treatment and catalyst conversion to allow the use of any indigenous sulphur bearing raw materials of suitable quality.

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Agenda Item : D. 3. 4

Canada

ANALYTICAL CHEMISTRY AND SPECTROGRAPHY AS ESSENTIAL CONTROLS FOR DEVELOPMENT AND PRODUCTION IN THE MINERAL AND METAL INDUSTRIES

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ANALYTICAL CHEMISTRY AND SPECTROGRAPHY AS ESSENTIAL CONTROLS FOR DEVELOPMENT AND PRODUCTION IN THE MINERAL AND METAL INDUSTRIES

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1. Development of Analytical Chemistry Instrumentation and Spectrographic Techniques and Apparatus in the Past Two Decades

(a) Prior to World War II the mining and metallurgical industries were able to cope with their analytical problems by means of the slow methods of classical analytical chemistry. There were, however, a number of laboratories in universities and government research institutes where instrumental methods were being investigated. This is true even of emission spectrography and polarography which, before the war, were practically unknown in industrial laboratories.

(b) The enormous demands on production of both well-established and new materials during the war brought sharply to notice the importance of analytical chemistry and the need for analytical control. It is true to say that one major wartime enterprise, involving the production of fissionable material, nearly foundered through initial lack of appreciation of the analytical effort and problem involved.

(c) The tremendous wartime and post-war increase in the number of chemical analyses required, found the western world acutely short of skilled analysts. In order to make up for this shortage, the development of instrumental methods, which were capable of operation by the semi-skilled technician, was greatly accelerated as the only possible solution to this urgent problem.

(d) Novel analytical techniques previously only practised by research workers in universities and research institutes soon became commonplace necessities in the industrial laboratories. In the past two decades widespread adoption has occurred of the polarograph, the spectrophotometer, the flame photometer, the infra-red spectrometer, the direct-recording spectrograph and the X-ray fluorescence spectrograph. Recently the vacuum spectrograph,

the gas chromatograph, the electron probe microanalyser and mass spectrometer have entered industrial research laboratories.

(e) In emission spectrographic analysis alone, the novel techniques of atomic absorption, carrier distillation, arc stabilization, the plasma jet and the application of the hollow cathode have been put to increasing use during the last twenty years.

(f) Analytical chemistry has been extended and enriched by applications and analytical developments of solvent extraction and ion-exchange methods and by the techniques of radiochemistry and isotope analysis.

(g) These new analytical tools have resulted in progress in the mineral and metallurgical industries. In the petroleum industry the advent of the infra-red spectrometer and the gas chromatograph have made possible analyses that previously were well-nigh impossible. New purifying techniques such as zone-refining have produced metals of hitherto unobtainable purity and the need for their analysis has resulted in many refinements of analytical techniques. The metallurgist has thus been provided with alloying constituents of a purity such that the effect of very small traces of impurities on the properties of alloys could be studied for the first time. The opportunity for the microanalysis of minerals and metals has been greatly increased by the introduction in recent years of the electron probe and its application to the identification of microstructure in alloys and minerals, and to the analysis of inclusions in metals and of corrosion products.

(h) It is obvious from the foregoing that the development of mineral resources and metallurgical industries by underdeveloped nations should not be hindered by any great difficulties in the field of analytical chemistry, provided that money is available for the purchase of modern equipment and that trained staff can be obtained. It is beyond the terms of reference of this paper to discuss the financial aspects, but staff training will be considered in a later section.

2. Present Status of Analytical Chemistry in Support of Mineral and Metallurgical Industries

(a) In the economic development of mineral resources from initial prospecting through process development to successful production, analytical chemistry plays an indispensable part. Through the years the improvement in methods of prospecting, the development of new and more efficient processes for winning metals from their ores and the production of high quality metals and alloys of constant composition, have been paced by advances in analytical chemistry.

(b) Prospecting

(i) The first phase of prospecting is the detection of valuable minerals. The modern prospector has available a number of physical and chemical aids. For example, small portable chemical kits have been designed which use simple methods for the estimation of valuable elements in water, vegetation and rocks. In the geochemical laboratory semi-quantitative results by spectrographic and chemical techniques permit the examination of a large number of samples in a relatively short time. Mobile laboratories have been developed that can be fitted with modern chemical instruments including the emission spectrograph, flame photometers and spectrophotometers. With such equipment available it is possible to investigate an area much more rapidly than in the past. All these facilities enable modern prospecting teams to select more readily the particular mineralized locations that hold promise of becoming mines.

(ii) When the potentially valuable areas are localized, and more intensive exploratory work is undertaken, more accurate analyses become necessary. Economically valuable metals, such as gold and platinum, rarely occur as high grade ores and very accurate trace analysis is necessary in the evaluation of their occurrence. When it is realized that one ounce of gold per ton of ore, or three one-thousandth of one per cent constitutes a rich ore, and one-fifth of that amount may be an economic ore, the necessity for accurate assays in the prospecting phase can be appreciated. Other elements such as platinum and rhodium normally occur in ores in even lower concentrations. Similar requirements arise with a number of strategic metals such as molybdenum, tungsten, niobium and uranium, which normally occur in the range of 0.1-2.0%. The list of elements of economic interest and value is steadily increasing; recently lithium, caesium, beryllium, germanium, niobium, zirconium, uranium and rare earths have all advanced from the status of purely academic interest to being materials of economic importance. Due to their chemical properties, these metals are difficult and tedious to determine in their ores by chemical methods. Instrumental methods are therefore necessary to make rapid and accurate determinations of these elements.

(c) Process Development

(i) When it has been established that ore occurs in sufficient quantity and grade for establishing a mine, the selection of the most efficient methods of beneficiating and otherwise processing the ore is undertaken.

(ii) In process development, particularly for complex ores, the knowledge and skill of the analytical chemist is at a premium. He is presented with compounds where the elements may be in unusual associations and in ratios that make separations difficult. Furthermore, due to the associations, segregation, resulting from gravity differences, may be a complicating factor.

(iii) All techniques and instruments in the field of inorganic analytical chemistry are required to support research in mineral processing, mineralogy and metallurgy. Emission spectrography, X-ray diffraction, X-ray fluorescence spectrometry and electron probe microanalysis are employed to reveal the distribution of the minerals contained in an ore and of the elements within the mineral grains. Wet chemical methods, electrometric techniques, flame photometry, spectrophotometry and fire assaying methods, in addition to those above, are used for the specific accurate assays required.

(iv) Although beneficiation of the ore is usually a physical treatment such as flotation or magnetic separation, the assessment of the efficiency of the operation depends upon the analytical laboratory. Not only should the analyst be competent and ingenious, but he should have an appreciation of the problems of the mining and metallurgical engineer. In this way he will not only provide the assays requested, but be in a position to suggest and perform other assays that might assist with the elucidation of the problem. In effect, when the ore-dressing specialist and analytical chemist are working as an understanding and integrated team, the best conditions for research are achieved.

(v) Pyrometallurgical processes for the reduction to metal, purification by liquid-liquid extraction in the uranium industry, pressure leaching, ion-exchange as used in rare earth separations, and distillation procedures for the separation and purification of volatile metals, all require analytical control to ensure efficient operation. Observing the increasing number of processes involved in modern metallurgy, and the wide variety of products, it is readily seen that the analytical services must be versatile. This is particularly true in the development stage. The premium on high-quality products makes it imperative that the process development be directed to this end. Conversely the "penalty metal" clause can render uneconomic a process that fails to remove the undesired impurity. Control of these aspects of process development is a function of the analytical chemist.

(d) Production

(i) Once an economic process has been developed its application to production requires continued analytical control. The production analyst may not have to contend with the wide variations in composition of materials that face his colleague in the development field, but the crude ores or concentrates for the production process may still, unavoidably, be far from constant in composition and require careful, accurate analysis to guide the process engineers in the modifications necessary to treat raw materials of varying composition.

(ii) The product is normally held to close quality tolerances and it is the analyst's responsibility to demonstrate that these requirements are being maintained by the plant. The fact that very little compositional variation is permitted in the product, permits the application of automation in analytical

control. For the production of materials such as ferrous and non-ferrous alloys, control is increasingly exercised by automatic instruments such as the direct recording emission- and X-ray spectrograph, and radiochemical methods are used in some analyses of very high purity materials. Normal methods of analysis are time-consuming and the application of rapid automatic methods of analysis can result in appreciable saving of time, and hence considerable savings in production costs. Process control concerned with changes in chemical concentration or acidity is clearly an extension of analysis from the laboratory into the plant, and in many plants such controls are indeed manned by staff from the analytical laboratory. Here also there is scope for automation to produce savings in the labour force and to result in less compositional variation in process streams than under manual operation. Although in-stream analysis has been developed largely by the chemical industries, particularly by those producing petroleum, heavy chemicals and foods, some instruments have been designed to do similar jobs, for the processing of ores. Siggia[1], in his recent book, reviews the field of continuous analysis applied to chemical processes and illustrates the use of X-ray spectrometry to monitor the quality of filter cake from ore processing. In setting up new plants in less developed countries, it should be worthwhile to consider the integrating of continuous in-stream analytical procedures. The advantages of instantaneous data are obvious and such systems are much cheaper when installed concurrently with the fabrication of the plant.

(iii) The general trend toward higher purity requirements for many materials, notably semiconductor ingredients, has made highly accurate analytical control of paramount importance. Even with common materials such as steel, cement and the like, it has been found that minute amounts of certain elements can profoundly affect the properties of the material, and the analyst is increasingly called on for routine analysis in the parts per million or even parts per billion range.

(iv) For such work, many ingenious refinements of emission spectrographic techniques have been developed, for the standard of purity demanded is so high that ordinary chemical reagents cannot be used because of their relative impurity. Recourse must therefore be taken to a method, such as emission spectrography, where little other than very high purity graphite is brought in contact with the material under examination. The spectrographic technique is, apart from the still uncommon methods of radioactivation analysis and solid-source mass spectrometry, the only means of determining impurities at these very low levels.

(v) The production analytical staff together with the production engineers are concerned with trouble shooting. Considerable analytical research may be required to discover causes for alterations in the grade, colour and other properties of the product. It is the function of the production staff to investigate immediate possibilities before referring the problem to the research laboratory.

(vi) The analytical laboratory in the plant is commonly required to provide services for the health and safety of employees. This usually involves determination of levels of toxic substances such as fumes, dust, etc., which result from the different stages of the process.

(vii) From the foregoing it is evident that the analytical laboratory may be required to perform a wide variety of analyses in the mineral and metal processing fields. In less well-developed areas, consulting and referee laboratories will probably not be readily available. Therefore, when planning analytical services, self-sufficiency must be emphasized so that production will not suffer from inadequacy of facilities to meet most contingencies.

3. Staff Requirements for Analytical Laboratories

(a) The staffing of a large or medium sized analytical laboratory in a mining and metallurgical industry in Canada will be described. Suggestions will be advanced as to how a similar laboratory in a less developed area might obtain the necessary personnel.

(b) In analytical chemistry laboratories serving development and production in Canada, the chief chemist usually is a university graduate with five or more years of experience following graduation, or has equivalent qualifications. It is desirable that the development analyst have, in addition, a higher degree, for originality and scientific leadership are needed to ensure that the analytical contribution to the overall research and development problem is adequate in all respects. The chief analyst should be the severest critic of the work put out by his laboratory and should instil in his staff those standards of scientific integrity without which confidence in the results of the analyst is quickly lost.

(c) In addition to a highly qualified chief analyst a number of university graduates, usually acting as project or group leaders, are also required. Most of the routine analytical work is performed by technicians whose training has been gained in one of two ways.

(i) One group completes secondary school and then attends a technical institute for a two or three year course in chemistry. These are well trained and, with experience, become competent analysts. The theoretical subjects included in their curriculum are usually sufficient to allow them to proceed to semi-professional status and in fact be classed as technologists.

(ii) The other category enters the laboratory directly from secondary school, in some cases without completing the course. Many of these, with several years training, become good routine analysts, capable of doing a wide variety of procedures. They are often most useful in instrumental analytical techniques. It must be realized, however, that certain of these, due to lack of ability, never become more than semi-skilled, tied to simple repetitive functions.

(iii) It, perhaps. should be again emphasized that automation and in-stream analyses allow a plant to function with a greatly reduced number of analysts. However, the analytical chemist, not the production engineer, is considered to be responsible for such equipment. This aspect is discussed thoroughly by Siggia[1].

(iv) In the underdeveloped areas, there are then, broadly, the two situations. Firstly, the provision of the highly qualified and experienced leaders of the analytical teams, and secondly, the training of unskilled locally recruited junior staff to provide the technical support.

a If the educational system of the countries concerned includes secondary schools, technical institutes and universities with adequate science faculties, no serious problem exists. Presumably these schools and universities could provide the basic training, and the necessary experience could be obtained in laboratories at home or abroad, as under the present Colombo plan.

b However many of these underdeveloped areas are deficient in centres of higher scientific learning. Persons desiring a career in science or engineering must go abroad to gain the academic qualifications and necessary experience to fit them for senior positions in analytical chemistry. Although this means of providing well-qualified chemists has some advantages, particularly with respect to gaining experience, it does not keep up with the demands of the growing industries. Rather exceptional talents and adaptability are required on the part of the individual, since he must become fluent in the tongue used in the country in which he studies, as well as devote his efforts to his scientific training.

c The alternative is that, for an initial period, highly qualified and experienced expert analysts be loaned to the underdeveloped areas, each expert serving for about three years. Their duty would be to guide the setting up of suitable analytical laboratories, and to advise on the appropriate analytical methods with respect to operation by locally recruited staff. In many ways the most important duty of all, is to start a training scheme for such staff. In this way, the particular industrial development would be supplied quite rapidly with a nucleus of reasonably skilled analytical workers. At the end of his term the foreign expert would select, from the staff he has trained, those whom he considers would benefit from a two- or three-year period of advanced training in similar laboratories of his own land. It is recommended that the majority of the advanced training be in the land of the tutor, for inevitably he will have given his trainees their preliminary instruction in the methods and on the equipment with which he is most familiar. In addition he can also ensure that they will get their further experience under the most advantageous conditions.

d From our observation, the practice of individuals being sent by the authorities of underdeveloped areas to gain further experience abroad does not, in all cases, result in a choice of the laboratories best suited to give the particular training required. In contrast, the foreign expert, who has seen and appreciated the peculiar problems of the particular underdeveloped area, is in a position to know which of the training grounds in his own country will give the trainee the experience of greatest value.

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item : D. 3. 4 Canada

ANALYTICAL CHEMISTRY AND SPECTROGRAPHY AS ESSENTIAL CONTROLS FOR DEVELOPMENT AND PRODUCTION IN THE MINERAL AND METAL INDUSTRIES

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NOTES

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ANALYTICAL CHEMISTRY AND SPECTROGRAPHY AS ESSENTIAL CONTROLS FOR DEVELOPMENT AND PRODUCTION IN THE MINERAL AND METAL INDUSTRIES

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SUMMARY

1. The development of analytical chemistry as related to the mining and metallurgical industries over the last two decades is reviewed briefly.

2. The development of a mineral and metal industry falls into three phases:

(a) discovery and mining of ore deposits;
(b) development of processes for extracting the valuable minerals and metals; and
(c) their economic production based on the work done in (b).

3. All phases require analytical control, with the highest skills and most sophisticated instrumentation required for phases (a) and (b). Obviously, it would be a vital part of the development to select the analytical methods that could be performed with the simpler, more rugged instruments whenever possible for the production phase. In fact modern plants should be designed, whenever possible to include in-stream analytical systems so as to have a continuous record of the quality of the ingredients and products.

4. Modern instrumentation utilizes a wide variety of methods for performing both simple and complex analysis; and instrumentation frequently offers the only feasible approach to difficult analytical problems. Among the analytical instrumental techniques used in a

modern mineralogical and metallurgical research institution are emission spectrography, X-ray spectrometry, electron probe microanalysis, flame emission and absorption photometry, spectrophotometry and polarography. Radiochemical techniques are useful in certain problems and can be done with relatively simple and inexpensive equipment.

5. In underdeveloped areas the availability of trained and skilled personnel may be a limiting factor in the efficiency of the analytical laboratories. It is considered that the preferable approach to this problem is, firstly, to have an expert work in the country, setting up the laboratory and training those who will be engaged in the analytical work; secondly, the most promising of these should be sent to the country of the foreign expert for advanced study and training.

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UNITED NATIONS CONFERENCE
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Agenda Item: D.3.3

India

STANDARDIZATION : A PRE-REQUISITE FOR DEVELOPMENT

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UNITED NATIONS CONFERENCE
ON
THE APPLICATION OF SCIENCE AND TECHNOLOGY FOR THE
BENEFIT OF THE LESS DEVELOPED AREAS

Agenda item : D.3.3 Specifications and standards

STANDARDIZATION: A PRE-REQUISITE FOR DEVELOPMENT

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INTRODUCTION

1. In the application of science and technology to industry, standardization provides the basis on which such application can take place for economic benefits to ensue. In fact standardization is an integral part of science and technology, for neither science nor technology could have developed without the standardization of units of measurements, of terms, symbols, formulae and the like.

2. Techniques of transformation of raw materials into finished products emerge from the development of science and technology. However, production is not an end in itself, the product must be able to satisfy some end-use. Standardization provides the link between production and consumption so that one may conform to the other. The latest definitions of standards and standardization accepted recently by the world's authority, International Organization for Standardization (ISO), are as follows:

(a) STANDARDIZATION - Standardization is the process of formulating and applying rules for an orderly approach to a specific activity for the benefit and with the co-operation of all concerned, and in particular for the promotion of optimum overall economy taking due account of functional conditions and safety requirements;

It is based on the consolidated results of science, technology and experience. It determines not only the basis for the present but also for future development, and it should keep pace with advances.

Some particular applications are:

1) Units of measurement
2) Terminology and symbolic representation
3) Products and processes (definition and selection of characteristics of products, testing and measuring methods, specification of characteristics of products for defining their quality, regulation of variety, interchangeability, etc.)
4) Safety of persons and goods

(b) STANDARD - A standard is the result of a particular standardization

effort, approved by a recognized authority. It may take the form of

1) a document containing a set of conditions to be fulfilled (In French "norme")

2) a fundamental unit or physical constant - examples: ampere, absolute zero (Kelvin) (In French "etalon")

3) an object for physical comparison - example: metre (In French "etalon").

3. The transition from production to consumption occurs not only at the ultimate point of use but also at a number of intermediary points both in industry and trade. The growth of industry in any country is marked by a corresponding rise in the inter-dependence of the different spheres of production on one another. Each has to look to others for the supply of raw materials, machinery, components and at times services; and each, in turn, provides similar facilities to others. The resulting complex relationship cannot be sustained unless adequate understanding is established for the innumerable contacts when products pass from one hand to another, be it within a plant, or from one plant to another, or from a store to a householder, or for that matter from one country to another. One of the main functions of standards is to facilitate the flow of products through these transition points.

4. Apart from helping commercial movement and industrial exchange in this manner, standards also conserve productive effort by reducing unnecessary variety, by ensuring interchangeability and by making mass production possible. Standards thus lead to the best utilization of man and material resources of a community or country.

5. For a less-developed country, co-ordinated development of industries, conservation of resources and achievement of high level of productivity are of obvious importance. So also is the need to boost exports to earn more foreign exchange to provide for the growing needs of importing capital equipment, so essential for initial development. Standardization, therefore, is a primary need for the development of newer countries.

STANDARDIZATION SPACE

6. The field of standardization is best represented by a hypothetical standardization space shown in Figure I (see Annex 1). The three dimensions of this space are 'subject', 'aspect' and 'level'.

(a) Subject: Standardization subjects are material things, abstract notions, formal symbols, etc, which are suitable for being standardized e.g., screw threads, limits and fits, graphical symbols. A related group of subjects belonging to any branch of economic or cultural activity is considered as a standardization domain. Such groups may be constituted in different ways in regard both to the guiding principles to be followed and the extent of a given domain to be defined. Following are some examples of standardization domains:

Engineering	Textiles
Transport	Chemicals
Housing/Building	Industry
Food	Commerce
Agriculture	Science
Forestry	Education

There being a large number of standardization subjects for each standardization domain, for the sake of convenience only standardization domains are indicated on the X-axis of Figure I.

(b) Standardization Aspect - A standardization aspect is a group of similar and related requirements of a standardization subject which are dealt

with in a given standard. Examples of standardization aspects are:

i) a set of nomenclature or definitions of terms;

(ii) a scheme for limitation of variety of sizes, shapes, grades or other parameters, designed to meet most economically the needs of the consumer. (This also includes dimensional freezing of component designs to ensure interchangeability);

(iii) constructional details;

(iv) a specification for quality, composition or performance of a material, an instrument, a machine or a structure;

(v) a method of sampling or inspection to determine conformity to a specified requirement of a large batch or lot of material or products by inspection of a sample;

(vi) a method of test or analysis to evaluate specified characteristics of a material or chemical;

(vii) a method of grading and grade definitions for natural products, such as timber, minerals, etc;

(viii) a code of practice dealing with design, construction, operation, safety, maintenance of a building, an installation, or a machine;

(ix) a code of practice for packaging, conservation or transportation of materials and products.

(c) Standardization Level - A standardization level defines a group of persons who are to use the standard. Standards corresponding to the more important levels occurring in contemporary practice may be classified as follows:

(i) a company standard, prepared by common agreement between various departments of a company or production unit for guiding its purchase, manufacture, sales, and other operations;

(ii) an association or trade standard prepared by a group of related interests in a given industry or within a given profession;

(iii) a national standard promulgated after consulting all interests concerned however remotely with the subject in a country, through a national standards organization which may be a governmental, a non-governmental, or a quasi-governmental body;

(iv) an international recommendation or standard, such as those of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), resulting from an international agreement between independent sovereign nations having common interests.

7. It is obvious that the standardization space described above is not a mathematical space of either continuous or discrete variables. It is to be regarded merely as a convenient device to illustrate the various attributes of standardization, which are of the nature of independent variables.

8. In addition to the three attributes, standards may also have a fourth attribute. The fundamental standards of science, those of weights and measures for example, are not expected to be changed from time to time, though refinements are often made in defining and maintaining these standards. By comparison, industrial standards are more temporary in character, being subject to revision with the development of science and progress of technology. In this context, standardization space may be considered to have a fourth dimension in time.

AIMS OF STANDARDIZATION

9. For a given standardization problem, it is possible to establish the specific aims of standardization by determining its position in the standardization space. However, there is no hard and fast division between the aims of standardization at, say, the national level as distinct from the aims at, say, the association level. The ultimate aims of standardization are applicable to all levels, though a distinct functional character may be ascribed to standards at each specific level.

10. The aims of standardization in general, applicable to all levels, are to achieve

(a) overall economy,

(b) protection of consumer interest, and

(c) safety and protection of health and life.

(a) Overall Economy - Overall economy comprises economy of human effort, materials and machines, power and energy, on the one hand and on the other, the combined economy of the producer and the consumer. The attainment of overall economy creates maximum productivity for the country as a whole, though the economy of individual units or components of production may not be at the optimum for each. For example, greatest economy in material may preclude greatest economy in labour. The pursuit of overall economy results in simplification and reduction of variety of products and components and elimination of avoidable wastage during handling of materials, processing, transport, and in general exchange of goods and services. It sometimes involves saving of essential materials by substitution with more readily available materials which may or may not involve immediate or apparent saving in cost of human effort but, in the national economy, conservation of such materials may be essential for other important reasons.

(b) Protection of Consumer Interest - Protection of consumer interest is ensured through adequate and consistent quality of goods and services. The notion of quality of service covers not only material services such as the attainment of higher quality or performance or functional interchangeability of consumer articles, but also non-material services and conveniences, such as ready availability of standard goods from stock, the simplicity coupled with serviceability of consumer equipment, and generally such things as makes man's life and work easier, more effective and pleasant.

(c) Safety and Protection of Health and Life - Provision for safety and protection of health and life is an essential element of those standards where safety requirements may arise. It may concern goods in general use or materials or processes during production. Examples are standards for limiting impurities in food stuff, standards for storage of radioactive materials, regulations for earthing of electrical wiring and equipment, etc.

11. Achievement of the aims discussed under (a), (b) and (c) above corresponds to the creation of order in industry, trade and commerce and in human relationships generally. Verily, it has been said by an eminent Indian thinker that standardization is to industry and commerce what culture is to society, that is, just as rules of civilized behaviour regulate social intercourse of man and his appreciation of cultural values enrich his intellectual and spiritual life, so does standardization help to regulate the conduct of commerce and trade in a smooth and efficient manner, and assist in improving productivity and efficiency of man and machine.

FORMULATION OF STANDARDS

12. It follows from the aims of standardization that standards must fulfil

the interests of both producers and consumers. This has given rise to a more or less universal procedure of formulating standards through intensive consultation among the interests concerned. The extent and details of such consultation may vary from country to country depending on the economic and political structure, but the fact remains that rarely standards are laid down arbitrarily by a superior authority without consideration of the views of those who would have to implement or observe them.

13. Obviously, the approach to the procedure for formulating standards would vary with the level of the standardization space (Figure I). Thus, at company level, depending on the size of the unit and the nature of its activity, company standards may be developed either departmentally or through formal committees representing the various departments of the company. In the latter case as also in the case of association and trade standards, the procedure followed and principles observed are generally comparable to those of national standards as discussed below.

14. At the national level, the national standards body or bodies of a country provide the forum for consultation among the national group interests. The normal procedure is to form expert committees with representatives from producers, consumers and technologists to prepare draft standards on the basis of common agreement. The draft standards are then widely circulated all over the nation to every important interest concerned with the subject matter of the draft. Comments are invited for further consideration by the expert committee, which takes final decisions and ensures that in the final form the standard represents the largest possible consensus of opinion within the country. It will be appreciated how a standard emerging out of such a procedure tends automatically to ensure the widest possible acceptability.

15. The organization of the national standards body should obviously be such as to facilitate the bringing together of the diverse interests in its forum. However, it would be natural to expect some variation in the pattern and status of national standards bodies in different countries. The status varies from purely non-official to purely official. In some countries, the national standards body is officially sponsored and supported, but its administration is left to a council or board of nominees representing government, industry, trade, commerce and other interests vitally concerned with standardization. For a developing country, this pattern seems to be most suitable as it enables official planning and direction to co-exist with the initiative of private enterprise.

16. The development of international standards follows the same principles and procedure as for national standards. The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) are the principal agencies of international standardization. The objective of ISO is to promote the development of standards in the world with a view to facilitating international exchange of goods and services and to developing mutual co-operation in the sphere of intellectual, scientific, technological and economic activity. As means to this end, it may

(a) take action to facilitate co-ordination and unification of national standards and issue necessary recommendations to member bodies for this purpose;

(b) set up international standards provided, in each case, no member body dissents;

(c) encourage and facilitate, as occasion demands, the development of new standards having common requirements for use in the national or international sphere;

(d) arrange for exchange of information regarding work of its member bodies and of its technical committees;

(e) co-operate with other international organizations interested in related matter, particularly by undertaking at their request studies relating to standardization projects.

The ISO membership is open to all national standards bodies. Its work is conducted through technical committees composed of delegations from member bodies wishing to take part in it.

17. The objective and working of IEC, which, though organizationally distinct but which functions as an electrical division of ISO, are similar to those of the latter. Its scope of work is, however, confined to electrical technology and may be described under the following two general categories:

(a) Work aiming at improving understanding between electrical engineers of countries by drawing up common means of expression; unification of nomenclature; agreement on quantities and units, their symbols and abbreviations; standardization of systems of units; and graphical symbols for diagrams.

(b) Standardization of electrical equipment, involving the study of problems of the electrical properties of materials used in electrical equipment; standardization of guarantees to be given for certain equipment as to their characteristics, methods of test, quality, safety and dimensions controlling interchangeability.

18. Whatever be the level of standardization, an important point to note is that standards belonging to a given level must take into consideration related standards at the higher and the lower level. The ideal is to achieve a pyramidal structure of standardization in which company standards form the basis of national standards and national standards form the basis of international standards. However, in no country the sequence of standardization can be made to follow any given pattern strictly. Resulting from the historical development of industry and commerce, one or the other level of standardization may be found to be more prominent. For example, in certain well developed countries such as the USA, company and association standardization activity is highly developed, in others like UK national standardization predominates.

19. In less-developed countries, industrial development is almost invariably dependent on the outside assistance a country is able to obtain and this assistance in the form of technical personnel, industrial know-how, capital equipment, etc, may come from a number of different industrial groups in different countries. Thus, every production unit in a newly developing country tends to adopt and follow the pattern of standardization of the parent collaborating organization. This is the time when national standards are most urgently needed for guidance and co-ordination and, more often than not, they are conspicuously their non-existence. So the prime need for a country aspiring to develop fast is to bring into being a system of national standards, which will help the development of industries from the earliest stage of planning and design, to erection, production and distribution. It is only through such an approach that the usually limited financial resources of a developing country and its indigenous raw material could be most effectively put to work.

20. It was fortunate, therefore, that in India the Indian Standards Institution (ISI) was brought into being in the year of her independence 1947. By the time the national planning effort was initiated in 1951, ISI had already done most of the spade work required for laying a sound foundation for a strong organization. As the country went from plan to plan and the industrial activity acquired momentum, demand for ISI standards and other services outpaced the man-power and physical resources of the Institution. The position today is that ISI, with its over 2 000 published standards, is in a position not only to guide the

existing industries in their effort to establish company standards, rationalize their productive effort and institute quality control measures, but it is also looked up to in planning future industries and in organizing export promotion effort.

21. The purpose of the organized standardization activity described above is not only to formulate the requisite standards, but also to keep them abreast of scientific discovery and technological advancement. Research in science and technology, therefore, plays an important role in standardization. In as much as the objective of a research is to make improvement over existing methods and means of production, by devising more economic, functionally more useful designs, by discovering more safe and more reliable materials, processes, methods, techniques of control, and the like, the objective of standardization is to make them readily applicable in day-to-day industrial practice. The fruits of research, therefore, furnish the basis on which standards are founded and when further advancements are made, the new knowledge helps improve existing standards through revisions and amendments. Standards thus move with scientific and technological development and enable industries to grow and improve as know-how expands.

IMPLEMENTATION OF STANDARDS

22. It is obvious that over-all economy and other benefits of standardization can only be secured, if standards are widely adopted and used in all walks of economic life of a nation, wherever they are applicable. Standards may be implemented either voluntarily or under obligation arising from existing legislations or from orders of higher authority. The social and economic structure of a country determines whether emphasis is laid on mandatory enforcement or on voluntary adoption. In a country where economy is completely controlled, standards are necessarily obligatory in nature. In a comparatively free economy, standards are by and large expected to be used without any compulsion, except perhaps in limited spheres.

23. The principle of voluntary implementation of standards is derived from the fact that standards are formulated by common consent of all interested parties to satisfy an existing need, and should, therefore, command ready acceptance by all concerned without legal pressure. Though this statement is generally true, it overlooks certain very important factors. Since standards are developed to satisfy the objective of overall economy, the economy of a particular use or of an individual user may at times be in conflict with that of another. Compromise between individual and overall economy is a normal feature of standardization and it may be generally expected that implementation of standards may cause some initial hardships at some places. Besides, a better understanding of the ultimate benefits of standardization grows only with the growth of industries and then again not without considerable effort being spent in promoting such understanding. Implementation of standards may sometime involve a change in the existing production equipment and procedure and the additional expenses and effort thus involved may seem at first sight unremunerative to the enterpreneur.

24. A great deal of persuasion and promotional work to spread the knowledge of standardization thus becomes necessary to secure voluntary implementation of standards. This is particularly an important phase of activity of national standardization bodies of developing countries, where dissemination of all knowledge assumes special significance. Indian Standards Institution is perhaps the first such body to organize an elaborate plan of publicity including paid advertisement in the press, besides exhibitions and fairs, films and slide, press notes and informative articles etc.

25. However, there are spheres of public life where the observance of standards cannot be left to chance, as for example where public health or public safety is concerned. Standards of purity of drugs and foodstuffs, electricity rules of safety for protection against electrical hazards are examples of this category. With the development of industries and the growth of the use of electricity in

industry and home, there is need to be more vigilant about safety to health and property. In a less-developed country, this aspect is likely to be overlooked in the initial stages of development, though it deserves much more serious attention than in a developed country.

26. Organized consumers in any country can set the pace for implementation of standards. If they adopt national standards for their purchases, a large enough demand for standard items would grow to enable producers to adjust their production accordingly. Once standard items are produced on a large scale, it would become uneconomical to supply non-standard or special products to cater to the needs of small purchasers, who would thereby be encouraged to adopt standard products. Thus a cycle of demand and supply of standard goods conforming to national standards could develop.

27. In a less-developed country, government departments and their attached or associated organizations perhaps form the largest bulk of organized consumers. It is within the competence of these organizations to purchase according to national standards but a policy directive from the highest governmental authority is necessary to crystallize action and give necessary clearance to purchasing officials. Once government takes a firm decision, it becomes possible to persuade other organized consumers in public or private enterprises to follow the lead. Government of India, in fact, has given such a lead, which is being taken up by States' Governments and more gradually by local authorities as well.

28. The growth of company standardization activity also helps implementation of standards, for the very purpose of company standardization is to provide a basis of standard practices and procedures for all activities of the company, including procurement of materials, designing of products, processing and manufacture, control of quality, sales and distribution etc. For a long term programme of implementation of standards, it is, therefore, essential to promote the knowledge and methodology of standardization at the company level.

CERTIFICATION MARKING

29. Another effective means of implementing standards is to provide certification marking facilities for goods conforming to accepted standards. A certification mark is a third-party guarantee to the purchaser that the goods have been inspected, tested and certified by or under the supervision of a competent agency and they may be purchased with a reasonable assurance of quality. The primary purpose that certification marking serves is to convey this assurance when the purchaser has no readily available facility for inspection and testing or when such testing is clearly uneconomical, such as for a small volume of purchase.

30. The principles on which certification marking schemes are formulated are two-fold. Firstly, the organization operating the scheme must be an independent and technically competent body with no business interest connected with production, distribution or supply of goods. Secondly, the operating organization must be satisfied that the manufacturing equipment, system of inspection and method of quality control available in the factory where the goods to be certified are manufactured, are adequate to ensure conformity with the accepted standards. In addition to this in-production control, an independent vigilance and a continuous check on quality is to be maintained by drawing samples from the production line and from stocks and from the open market, tests being conducted either by the operating organization itself or at its instance by independent laboratories.

31. The national standards body of a country is undoubtedly the best suited agency to operate certification marking schemes. Many national standards bodies have in fact extended their functions to this activity. The authority for operating such schemes is sometimes derived from existing legislation, which may permit the registration and operation of certification marks, or from

special legislations enacted for the purpose. In India, a special legislation exists, 'The Indian Standards Institution (Certification Marks) Act, 1952' which empowers the Institution to

(a) establish and publish, in such manner as may be prescribed, the Indian Standard in relation to any article or process;

(b) specify a Standard Mark, to be called the Indian Standards Institution Certification Mark, which shall be of such design and contain such particulars as may be prescribed to represent a particular Indian Standard;

(c) grant, renew, suspend or cancel, in such manner as may be prescribed, a licence for the use of the Standard Mark;

(d) levy such fees for the grant or renewal of any licence as may be prescribed;

(e) make such inspection and take such samples of any material or substance as may be necessary to see whether any article or process in relation to which the Standard Mark has been used conforms to the Indian Standard, or whether the Standard Mark has been improperly used in relation to any article or process with or without licence.

32. Under this legislation ISI has currently some 400 licences in operation in some 250 production units. They relate to about 125 Indian standards covering as many products, and the total annual production under these licences is estimated to reach in the near future the equivalent of some 475 million US dollars. Under another Indian legislation, agricultural products are graded and certified, which includes a good many export commodities. Under this system, a total annual production amounting to some 150 million US dollars is covered. Though all this represents a fraction of national production today (say about 2 percent), yet a good beginning may be said to have been made for a newly developing country.

33. Certification marking has obvious advantages both to the producer and to the consumer. A small consumer, even though willing to pay a little extra for quality, can never be certain of the quality he buys, since more often than not he has neither the means nor the requisite experience and knowledge for checking the quality. Certification marking simplifies his problem. It is also welcome to industrial and organized purchasers as a guarantee of quality and performance. For the producer, the mark on the one hand affords protection against unfair competition with cheap and non-standard goods and on the other brings him the assistance of a competent agency which evaluates and maintains the standard of his production.

34. It is desirable that the government of the country should lend its support to encourage certification marking by the national standards body. If government as the biggest organized consumer agrees to give certified goods some preference, either in price or otherwise, in all official purchases, it would go a long way in establishing certification marking in industry and trade.

35. For the export trade of a less-developed country, certification marking operated by the national standards body could become even more valuable than in the internal trade. With certified goods, it would be easier to convince overseas customers of the quality of supplies, making pre-shipment post-landing inspection superfluous and unnecessary. The legal provision of penalty against the misuse of certification marks is an additional guarantee for consumers in the home market and abroad. Apart from the penalties, suppliers are also under obligation to replace, free of cost, any defective supplies bearing a certification mark.

36. It may be of interest to mention here that through government regulation, it has been banned to export from India any of the following products unless

they are duly certified by one of the two agencies mentioned above:

1. Aluminium utensils
2. Tea unless packed in certified tea-chests
3. Tobacco
4. Sandalwood oil
5. Lemon grass oil
6. Raw wool
7. Sun hemp
8. Bristles

Bringing other products under similar coverage is constantly under consideration, but a demand arising from overseas purchasers is bound to accelerate this process.

URGENCY OF ACTION BY LESS-DEVELOPED COUNTRIES

37. The foregoing gives a brief account of the background against which the organized standardization activity is being carried out nationally and internationally, with a few illustrative examples. The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), together with the national standards bodies of some 46 countries, provide the world wide organizational net-work for this activity. As a distinct economic activity, standardization has grown quickly over the last 40 or 50 years. Its present magnitude and rate of growth indicates that the basic concepts and procedures crystallized over these decades are sound in principle and that the possible benefits have become widely enough recognized to gain active support from those primarily concerned.

38. In industrially developed countries, the present concept of standardization has grown up from recognition of the need to co-ordinate, adjust and bring about economy and harmony in the existing pattern of industries, where industrial production has often preceded standardization. It does not necessarily follow that the same sequence of historical development would be suitable for less-developed countries also. On the contrary and for obvious reasons, co-ordination is more difficult at an advanced stage of development than in the early stages. One major factor is the vested interests and the consequent cost and inconvenience of making a change in the schedule or pattern of production. The experience of national standards bodies of industrially developed countries bears adequate testimony to the manifold difficulties that have to be overcome for introducing standardization in existing enterprises. It is as a result of this experience that they have become more vigilant, particularly in respect of the newly developing industries, for example in the field of nuclear energy, automation, electronic computers and the like.

39. For the less-developed countries, therefore, it would be much more beneficial to let standardization precede industrialization, particularly at the national level with such guidance as may be available from the existing international standards and recommendations of ISO and IEC or even without such guidance, if need be. Industrial planning has of necessity to presume the existence of some standards, and besides economic gains to be achieved from pre-planning of standardization can be of considerable magnitude particularly for a developing country. The steel economy project of the Indian Standards Institution may be cited as an example.

40. The aim of this project was to achieve economy in the use of steel in structures through the adoption of standards all along the line from the stage of production, through design, fabrication and erection, to use and maintenance. In production, considerable emphasis was given to the rationalization of shapes and sizes of sections, whose designs had been frozen years ago. New standard sections now developed by ISI save about 10 percent of steel and all the new mills installed during recent years in India or to be installed in future are to produce these new sections. The use of cold-formed sections made from strip is also being standardized which could save up to 40 percent of the steel material. Standards for welding equipment and accessories and codes for welding practices have been developed to further economize on steel by eliminating

rivetting. Similarly, the new and improved design codes for steel structures now enable Indian engineers to use more rational factors of safety and loading criteria and also permit the use of more economical and up-to-date formulae for designs.

41. On a conservative estimate, about 20 per cent of steel may be saved, if all these measures now available to the engineer are fully implemented. In the context of 10 million tons of production of steel, an appreciable quantity of which is used for structural purposes, a saving of even 1 million tons per year would amount to the equivalent of well over 100 million dollars. Compared to this the cost of steel standardization project was a mere flee-bite.

42. A part of the steel economy project was concerned with rationalization of the varieties of alloy and special steels required for miscellaneous industrial uses. Indian industries, like those of most other newly developing countries, import equipment and know-how from all parts of the world, which has resulted in the demand for well over one thousand types of special and alloy steels including tool steels, based on a variety of overseas specifications of various industrial groups in different countries. The position is not only wasteful, but it also precludes the possibility of indigenous production as the demand for each type of steel is necessarily very limited. After an extensive study, it has been possible to reduce drastically the varieties of alloy and special steels to some 130 varieties and also to minimize the use of imported alloying elements, such as nickel and molybdenum and to maximize the use of indigenously available alloying elements such as manganese and chromium. As a result of this project, it has now been possible to proceed with the schemes for setting up several new alloy steel plants, a number of which are currently under construction.

CONCLUSION

43. In planning for standardization, developing countries have an obvious advantage over the developed countries. They have the possibility to learn from the accumulated experience of other countries as reflected in the latters' published standards and more so from the recommendations of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). This vast store of knowledge and experience is there to draw upon and to enable developing countries to plan their industrial development with the least amount of wastage and conflict and with utmost expedition. But the existence of a national standards body is an essential pre-requisite, for it is only through such a specialized agency that a developing country can channelize the two way traffic of knowledge and experience that standardization essentially implies.

ANNEX 1

ANNEX 1

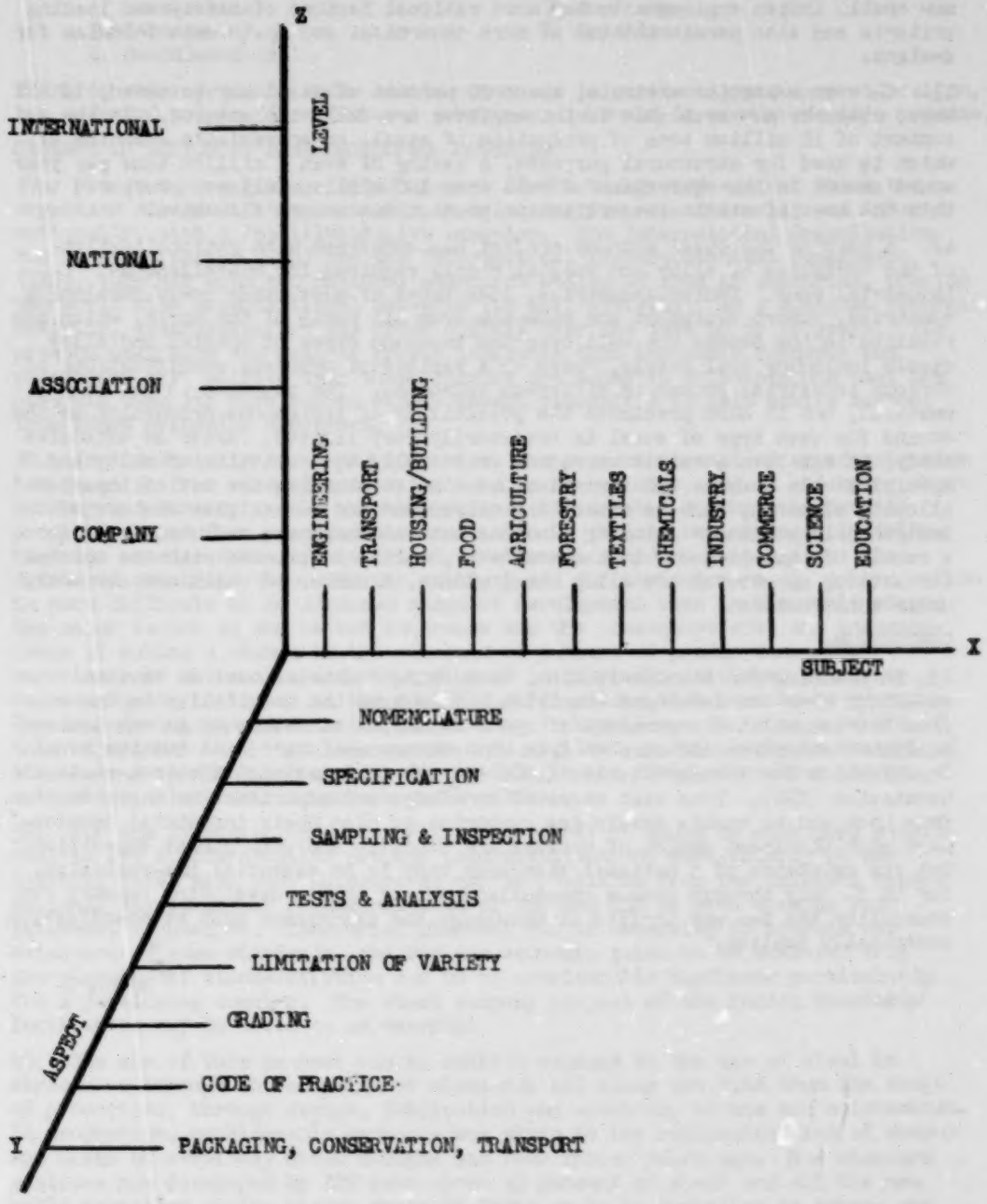

FIGURE I DIAGRAMMATIC REPRESENTATION OF STANDARDIZATION SPACE

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D. 3. 3

India

STANDARDIZATION:
A PRE-REQUISITE FOR DEVELOPMENT

By Dr. Lal C. VERMAN,
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of India on Standardization

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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UNITED NATIONS CONFERENCE
ON
THE APPLICATION OF SCIENCE AND TECHNOLOGY FOR THE
BENEFIT OF THE LESS DEVELOPED AREAS

Agenda item : D.3.3 Specifications and standards

STANDARDIZATION: A PRE-REQUISITE FOR DEVELOPMENT
(Author's Summary)

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1. Standardization provides the link between production and consumption not only at the ultimate point of use, but also at the innumerable points of contact in industry and trade where products pass from one hand to another. The main function of standards is to facilitate the flow of products through these transition points and having arrived at destination to fit in with the intended end-use. This applies equally well to services. Apart from helping industrial movement in this manner, standards also conserve productive effort by conserving materials, by reducing variety, by ensuring interchangeability and by making mass production possible, without in any way creating monotony.

2. The field of standardization extends to all branches of economic and cultural activity of man and can be analysed by the three attributes of standardization, namely, 'subject', 'aspect' and 'level'. These three attributes may be considered as the three dimensions of a hypothetical standardization space.

3. The aims of standardization are to achieve (a) overall economy, (b) protection of consumer interest and (c) safety and protection of health and life. Overall economy comprises economy of human effort, material, power, etc, on the one hand and on the other, the combined economy of the producer and the consumer. The attainment of the above aims corresponds to the creation of order in industry, trade and commerce and in human relationships generally.

4. Standards are formulated through intensive consultation among producers, consumers and other interests concerned with standardization. The national standards body of a country provides the forum for consultation among national groups. The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) are the principal agencies for international standardization.

5. The organization of the national standards body should be such as to facilitate the bringing together of the diverse interests in its forum. Some variation is observed in the pattern and status of national standards bodies in different countries. The status varies from purely non-official to purely official. For a less-developed country, a semi-official organization seems to be suitable as it enables official planning and direction to co-exist with the initiative of private enterprise.

6. Standards are implemented either voluntarily or under obligation arising from existing legislations or from orders of higher authority. In a country where the economy is completely controlled, standards are necessarily obligatory. In a comparatively free economy, standards derive their authority from the fact that they represent commonly acceptable solutions, as ensured through the procedure adopted for their preparation. However, even in free economies, there exist spheres of public life where observance of standards cannot be left to chance, for example when public health or public safety is concerned.

7. Marks indicating compliance of goods with standards usually known as certification marks or standard marks provide a useful means to make benefits of standardization available to common man. A certification mark is a third party guarantee to the purchaser that the goods have been inspected, tested and certified by a competent and independent agency and may, therefore, be purchased with a reasonable assurance of quality.

8. Certification marking authorized by the national standards body of a country has obvious advantages. It solves the problem of small consumers, who are willing to pay for quality but can never be sure of it. It is welcome to industrial purchasers as a guarantee of quality and performance. To the producer, it affords protection against unfair competition with cheap and non-standard goods. For export trade, it has the particular merit of furnishing a means to convince overseas customers of the quality of supplies. The legal provision of penalty against the misuse of certification marks is an additional guarantee for consumers in home market and abroad.

9. The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), together with the national standards bodies of some 46 countries, provide the worldwide organizational net-work currently engaged in standardization as a distinct economic activity. In industrially developed countries, industrialization has often preceded standardization, but in less-developed countries it would be more beneficial to let standardization precede industrialization, since co-ordination is more difficult at a developed stage than at the initial stages of planning.

10. In planning for standardization, developing countries have an obvious advantage over developed countries. They have the possibility to gain from the accumulated experience of other countries as reflected in the latters' published standards and more so from the recommendations of ISO and IEC and plan their industrial development with the least amount of wastage and conflict and with utmost expedition. But for this complex task, it is essential to create a national standards body with adequate means at its command.

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Agenda Item: D.5.1

Nigeria

THE UTILISATION OF TROPICAL HARDWOOD PLANTATION TIMBERS FOR PULP AND PAPER MAKING

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The Utilization of Tropical Hardwood Plantation Timbers for Pulp and Paper Making

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1. Introduction

(a) The demand for paper and paper products is increasing rapidly throughout the world, but this increase is especially marked in the new developing countries of Asia and Africa. The technical, cultural and educational developments taking place in these countries have already resulted in greatly enlarged imports of paper and, as development programmes are implemented, and education spreads, this trend is likely to accelerate greatly. In Nigeria, for example, during the six years immediately prior to the attainment of Independence in 1960, the annual expenditure on paper and paper products increased from about £1 million to nearly £3 millions.

(b) Most of the developing countries are traditionally primary agricultural producers, but with the social and political awakening of the last decades, the growth of industries is proceeding rapidly in many tropical countries. The manufacture of paper is an industry that often attracts considerable attention in development programmes: in view of the rapidly growing demand for paper products, the development of this industry appears desirable. It must be borne in mind, however, that special problems arise in connection with the establishment of pulp and paper industries in developing tropical countries; although these problems can be overcome by adequate planning and research, it is well not to underestimate them.

2. Problems of the Paper Industry in Developing Countries

(a) Perhaps the most important problem in the establishment of a paper industry in a new, relatively under-developed country is that of scale.

(i) Paper making is essentially a large scale operation, and cannot be conducted profitably at an output below a certain level. This minimum output has been variously estimated by

different experts, and, of course, varies with the economics of the individual country, and the type of raw material and process used, but it is unlikely that, in an underdeveloped country, with high overheads and supervisory costs, and where chemicals, etc. have to be imported, a production of lower than 20-30 tons/day would be commercially successful.

(ii) The total paper requirements of many of the smaller developing countries do not as yet approach this figure, and, in these cases, it would seem wise to defer any consideration of the establishment of a paper industry until such time as the demand may reach this level. In this respect, however, Nigeria is in an especially fortunate position to embark on the manufacture of paper. Extrapolation of available import figures suggests that the paper requirements of this country will pass 100 tons/day by 1965, a requirement which can fully absorb the production of a general purpose mill.

(b) Another major problem is that of technical expertise. The paper-making industry antedates the scientific revolution, and depends to a great extent on the traditional skills of the craftsman. It has been said that "it takes three generations to make a paper maker" and, although this may be an exaggerated view, there is no doubt that these traditional craft skills cannot be acquired overnight. The training of craftsman for the paper industry in the newer countries, where few traditions of such skills exist, is likely to be more difficult than staffing the industry at the management and engineering levels.

(c) The third important problem, consideration of which leads on to the main theme of this paper, lies in the unfamiliarity to the paper-maker of the locally available raw materials.

(i) The paper industry has developed mainly in Northern countries where the most readily available cellulose is that derived from the natural coniferous forests of the temperate and sub-arctic regions of the Northern Hemisphere. These softwoods are inherently suitable for the manufacture of paper pulp, on account of their comparatively long ultimate fibres, their relative ease of pulping, and many other characteristics. A great deal of information and experience has been built up around these materials, and they are by far the most familiar source of cellulose fibre to the paper-maker. The non-traditional raw materials available in tropical countries are comparatively little known, and difficulties in their use may be encountered.

(d) Many other problems also may arise, but are beyond the scope of this paper, which is mainly concerned with the provision of suitable cellulosic raw material.

3. Indigenous versus Imported Pulp

(a) Before proceeding to this main theme it may be appropriate to consider the policy of operating a paper mill

in an emergent country on the basis of imported pulp

(b) The policy may well be a wise one in the early stages of the development of the industry. Pulp could be imported from the established producer countries, at prices which are likely to compete favourably with those at which pulp can be manufactured locally. The new paper making industry can then have an opportunity to establish itself securely, using a familiar type of pulp, before the additional capital expenditure on a pulp mill is incurred, and while necessary research on the local raw materials is being undertaken.

(c) However, to plan a new paper industry to be operated indefinitely on the basis of imported pulp would probably not be ultimately in the best interests of the economy of the country.

(i) Cellulose is one of the most ubiquitous of natural products, and there is hardly a country in the world which does not produce sufficient to satisfy the local paper-making requirements. As most of the new developing countries are traditionally primary producers, it is desirable to link their newly expanding industries to local raw materials, thus giving encouragement to existing agricultural and forestry operations.

(ii) If the economics of the paper mill are considered in isolation, the continued use of imported pulp may appear favourable. This policy implies, however, that the paper industry is continuing to be dependent on the industrial and forestry operations of the established industrialized countries - which the industry of a developing country can ill afford to be.

(iii) Even if slightly lower profit margins in the paper mill itself result from the use of locally manufactured pulp, this will mean that the mill is subsidizing other operations, industrial, agricultural or forestry, within its own country.

(d) This problem must also be considered from the point of view of the availability, on the global scale, of pulpable raw materials. Although the softwood reserves of the northern forests are far from being exhausted, considerable depletion of available supplies has already taken place, and attention is being paid, even in the established producer countries, to the exploitation of less conventional materials. Against this background, the increased use of tropical cellulosic materials appears even more desirable.

(e) In summary, it is considered that wherever possible a paper industry in a developing country should be based on locally manufactured pulp, although the use of imported pulp may be expedient during the earliest years of the establishment of the industry.

4. Alternative Sources of Pulp

(a) Three main sources of pulping material must be considered in addition to hardwoods: these are; waste paper and rags; agricultural residues; and softwood timbers. These materials are all used for the manufacture of pulp, but the conditions prevailing in underdeveloped countries may seriously limit the choice of materials suitable for local utilization. The materials may be considered briefly:-

(b) Waste Paper and Rags

(i) In most highly industrialized countries, very considerable quantities of waste paper are collected, and repulped. At the present time, however, no organized collection of waste paper is made in most of the developing countries, and it is unlikely that quantities large enough to be worth the effort of collecting and sorting would be available at any one centre, except possibly in a few of the largest towns, for some years to come. Furthermore, stock prepared from waste paper pulp is in general only suitable for the manufacture of lower grades of cardboard, and similar materials.

(ii) In view of these considerations, it is suggested that, at the present time, waste paper is not likely to prove a useful raw material for the pulp/paper industry in developing countries. As paper consumption increases, however, this position may change, and it is well to keep the possibilities of this material under review.

(iii) Although the highest quality papers can be made from rags, the availability of this material in the less developed countries is entirely insufficient to warrant its serious consideration. Furthermore, the local demand for high quality rag papers is likely to be very small.

(c) Agricultural Residues.

(i) Although agricultural products, such as straw, are widely used for the manufacture of paper pulp in countries where agricultural operations are highly mechanized, it does not follow that similar raw materials are likely to be particularly promising in the less developed areas of the world.

(ii) Agriculture in these countries is based largely on the production of peasant farmers, cultivating individually small plots, so that the logistics of obtaining a sufficient quantity of bulky material in any one place becomes a major problem. Production in most cases is highly seasonal, and storage of such materials under tropical conditions for protracted periods may result in serious loss of quality. Further, such materials already serve a number of useful purposes in rural economies (thatching, manufacture of matting and cordage etc.) and the disruption of such trades and crafts is undesirable.

(iii) An exception to these generalizations, however, is bagasse, which material already finds extensive use in the paper industry in many countries, and whose use could doubtless be increased, where sugar cane is grown. Even in this case, however, there is the disadvantage of seasonal production.

(d) Softwood Timbers.

(i) Where softwoods are readily available as part of the natural forest of the country concerned, they will normally be a preferred raw material to the paper pulp manufacturer. Many coniferous species, for example the tropical pines such, as Pinus caribaea and P. taeda, are already extensively used as pulpwoods in tropical and sub-tropical countries.

(ii) In many of the emergent countries, especially in Africa, no natural coniferous forests exist. In some cases, exotic conifers have been introduced, and successfully established on a plantation scale (for example, Cupressus and Pinus spp. in Kenya). W here this has taken place, these materials can doubtless be of great value to a pulp industry.

(iii) From a long-term point of view, there is scope for extensive forestry research on the introduction of coniferous species in other tropical countries, but, where no such introductions have yet been made, it must be many years before they can contribute anything to a pulp industry. Special problems are associated with the establishment of coniferous species in soils and climates alien to them which may limit indefinitely the exploitation of such species in many of the new countries.

5. Hardwoods

(a) It remains to consider the hardwoods, which constitute the greater part of the forest cover of the majority of tropical countries. The term "hardwood" is used here as it normally is in the paper industry, to include all broad-leaved (i.e. non-coniferous) trees.

(b) The traditional paper making materials, as indicated above, are softwoods derived from temperate or sub-arctic coniferous forests. Even in the established pulp-producing countries, however, considerable attention is now being given to the use of hardwoods for pulping, especially thinnings from saw timber plantations, and new pulping techniques, suitable for hardwoods, have been developed.

(c) Natural Forest Hardwoods

The exploitation of existing tropical forests for pulpwood presents major problems.

(i) Extraction costs from dense high forest are often high, on account of difficulties of communication and access. These high costs may well be justified in the case of valuable saw and veneer timbers, but are less easily borne by the cheaper pulpwood.

(ii) Tropical forests are usually heterogenous in composition. Selection of a single species for pulping would be difficult, while mixed hardwoods generally yield pulps of only indifferent quality, which tend to be expensive, in terms of chemical consumption, to produce.

(iii) Regeneration of tropical forest after cutting is a complex process, and often gives rise to secondary forest of a very difficult composition to that originally existing.

(iv) Tropical forest species often command a higher price as timber than they would as pulpwood: this is especially true of many of the valuable West African veneer timbers.

(d) Plantation Hardwoods

It is not always realized how rapidly plantations of some tropical hardwood species can be established, under favourable conditions.

(i) As an example, figures may be quoted for the Asian species, *Gmelina arborea* Roxb., which is already well established in Nigeria and other West African countries, being used for firewood plantations and low-grade timber. Growth rates naturally vary with soil and rainfall, but a harvest of over 3000 cubic feet per acre, of a suitable size for pulping, can reasonably be expected after as little as 8 years growth in the Rain Forest zone, 10 years or more being required for the same yield under savannah conditions, given reasonable soil conditions. This species can yield a pulp suitable for the manufacture of writing and wrapping papers.

(ii) Many other quick-growing hardwoods are known, which are already being used on a plantation scale in West Africa for the supply of firewood, and similar purposes. These hardwoods in many cases have a great advantage in that, once established, they can be coppiced regularly, and the timber thus harvested at frequent intervals - of only a few years, under optimum conditions - without the expense of replanting. Of all hardwoods, the eucalypts are probably the best known for their quick-growing characteristics, but species of *Cassia*, *Tectona*, *Terminalia* and *Triplochiton* are also well known in West Africa.

(e) Afforestation thinnings

Apart from the possibility of establishing plantations of quick-growing hardwoods specifically for the production of pulpwood, the thinnings from plantations of hardwood saw timber species must also be considered. As silviculture develops, it is likely that increasing areas in many of the emergent countries will be devoted to artificially planted forests of the more desirable timber species. In some cases, large quantities of thinnings from these forests may become available for pulping, as is already the case in some of the more industrialized countries.

6. The Use of Marginal Land

(a) Extensive areas in many of the emergent countries, especially in Africa, are of a semi-arid nature, frequently more as a result of a long dry season than of low total rainfall. These areas are unsuitable for normal forestry operations aimed at the production of high-quality saw timber. Unsatisfactory agricultural techniques have often resulted in the widespread destruction of existing forest cover, and soil erosion is becoming a major problem.

(b) Some of the poorer quality hardwood species available, however, can be grown under these adverse conditions: if the timber so produced can be exploited industrially for the manufacture of paper pulp, a stimulus will be provided for the afforestation of such areas. Afforestation of savannah country - which, at least in West Africa, is often "derived savannah", i.e. land which was once forest, and has been degraded to grassland or scrub as a result of human influence - will, in its turn, produce many benefits in the form of erosion control. and possibly even amelioration of climate, together with local social advantages.

(c) It is considered, therefore, that a paper industry, if supplied by locally manufactured pulp from suitably selected plantation timber species, can contribute greatly to the exploitation of the marginally useful savannah lands that form such a large part of the available land space in many tropical countries.

7. The Need for Research

(a) In view of the relative unfamiliarity, to the paper maker, of most tropical hardwoods, extensive research will be necessary in order to ensure effective and economic utilization.

(b) Pulping and paper making trials have already been made on a considerable number of tropical hardwoods.

(i) Most of this work, however, was carried out in laboratories situated thousands of miles from the country of origin of the material. Although these investigations - made, notably, in the United Kingdom, France and Belgium, - provide a useful basis for further work, their value is, in many cases, subject to considerable limitations.

(ii) Research in this field can best be conducted in close liaison with the various interested parties, especially the Forestry authorities of the country concerned. Priority can then be given to the investigation of those species which are already known to the forester, and which are likely to be capable of being grown successfully under the locally prevailing conditions. Satisfactorily representative samples can easily be obtained for pulping trials, and the variation in properties with age, climate, soil, etc. can effectively be studied.

Material used for experimental work can be freshly cut, or, if desired, stored under known conditions for definite periods. These desiderata have rarely been achieved in the investigations carried out in overseas laboratories, where the research workers frequently have little knowledge of the relevant local conditions, and are, in any case, remote from their supply of experimental material.

(c) As an example of the successful application of research in this field may be instanced the work carried out in Australia on the pulping of various species of Eucalyptus. The Australian paper industry now depends to a very large extent on locally manufactured Eucalyptus pulp, although much opposition to the feasibility of its use was encountered in earlier years, and a heavy expenditure on research had to be made.

(d) Among the newly emergent countries, in West Africa, Nigeria is pioneering the investigation of tropical hardwoods, with especial reference to species suitable for plantation development. The Federal Institute of Industrial Research, at Oshodi, near Lagos, is now equipped to carry out pulping and paper making trials, and the testing of paper under recognized standard conditions. Few results are available to date, as this section of the Institute was fitted out only in 1961, and special arrangements have had to be made for the training of staff, but it is hoped that, in the near future, valuable research on the pulping and paper-making uses of tropical timbers may be carried out, leading to the establishment of a successful indigenous pulp industry, and the afforestation of substantial areas of marginal land.

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SUMMARY

Agenda Item: D.5.1 Nigeria

THE UTILIZATION OF TROPICAL HARDWOOD PLANTATION TIMBERS FOR PULP AND PAPER MAKING

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NOTES

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SUMMARY

The Utilization of Tropical Hardwood Plantation Timbers for Pulp and Paper Making

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The growth of political autonomy and improvements in educational and cultural standards in many of the emergent countries in the tropics have led to greatly increased consumption of paper and paper products. At the same time, there is a growing demand for industrialization where, until recently, only agricultural raw materials have been produced. In many countries, the establishment of paper industries is therefore receiving consideration, or has actually been achieved. It is desirable, in countries with long traditions as primary producers, to utilize local raw materials for the developing industries.

In the case of the pulp/paper industry, especially, ample supplies of cellulosic raw material are usually available, although they may often be of a kind unfamiliar to the paper-maker. Other problems, especially that of economic scale of operation, may also arise when a paper industry is established in a newly developing country.

Most of the world's paper is at present manufactured from the softwoods of the temperate and subarctic zones. These traditional sources are becoming inadequate to meet rising demands, and a trend toward the utilization of hardwoods is developing, even in the established producer countries.

The most readily available materials in West Africa are hardwood timbers, while many of the more conventional paper-making materials are not available in adequate quantities. However, not only are the natural forests usually very mixed in composition, rendering difficult their use for pulping, but many of the species command high prices as lumber, and are thus uneconomic for use as pulp wood. Considerable opportunities exist for the development of plantations of quick-growing hardwoods. Species of Eucalyptus are already making a very major contribution to paper pulp supplies, especially in

Australia, while many other genera appear to have possibilities, for establishment on the plantation scale in the drier parts of West Africa, which are unsuitable for the production of saw timber. Softwoods, such as the tropical pines, also warrant attention, but difficulties have been experienced in establishing coniferous trees in foreign soils. Unlike many hardwoods they cannot be coppiced, so that a recurring regeneration problem exists. The establishment of such plantation can not only serve to stimulate industrial development based on local raw materials, but can also have beneficial side effects, such as erosion control.

Extensive research is still needed on these materials, and collaboration between Industrial and Forestry authorities is necessary to ensure the best utilization of resources: the value of much research previously undertaken in the past has been substantially reduced by the fact that such liaison has been difficult when the pulping trials have been carried out in temperate countries, remote from the sources of supply.

In Nigeria the Federal Institute of Industrial Research has recently initiated a research on locally available timbers, and other possible pulp sources, in close liaison with Forestry and Agricultural authorities.

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